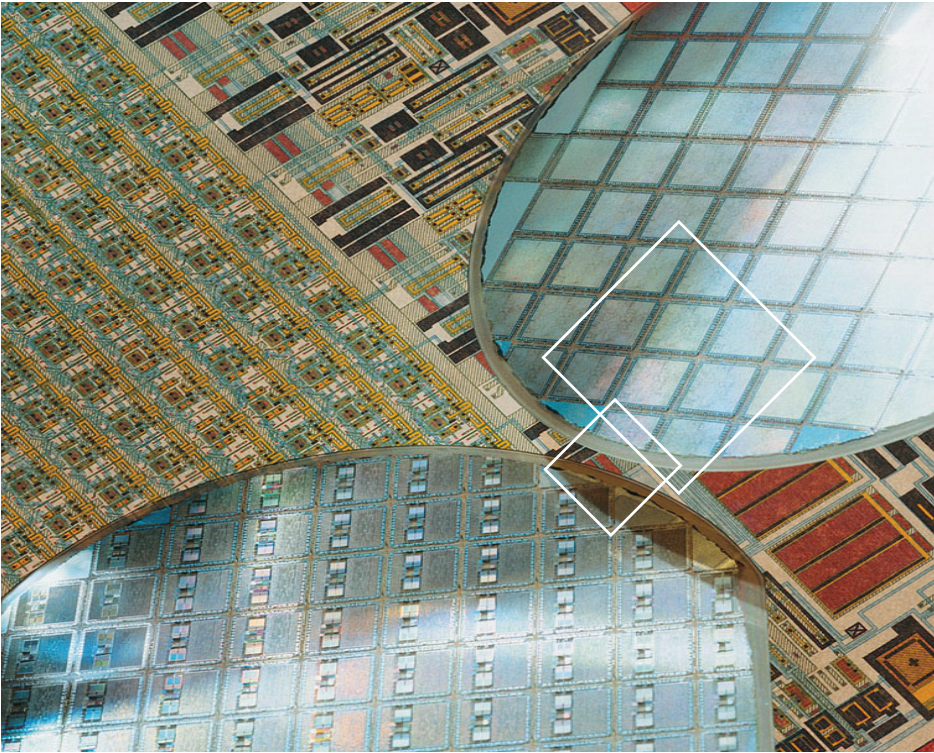


Analog, Mixed Signal, and Power Management

Technology

Why Use Freescale's *SMARTMOS* Products?

- **HIGHLY CAPABLE** — providing full flexibility of integration
- **ROBUST** — developed for applications demanding a high level of environmental tolerance, required in automotive and industrial applications.
- **COST-EFFECTIVE** — appropriately balanced analog, power and CMOS logic (*SMARTMOS*) capabilities providing cost-effective solutions
- **INNOVATIVELY PACKAGED** — Freescale's innovative multi-die packaging options exploit strengths of both *SMARTMOS* and HDTMOS technologies to offer reduced cost and space.
- **CONSTANTLY IMPROVING** — Freescale has supplied over 2 billion Automotive *SMARTMOS* ICs since 1991. We are currently shipping products in our 8th technology generation.



SMARTMOS technology, in combination with HDTMOS and discrete FETs, for very high current capability, is Freescale's predominant process technology, which combines precision analog, high voltage, high current power capabilities and high speed CMOS in a single package.

INTEGRATION

Freescale's Products using SMARTMOS technologies possess these features:

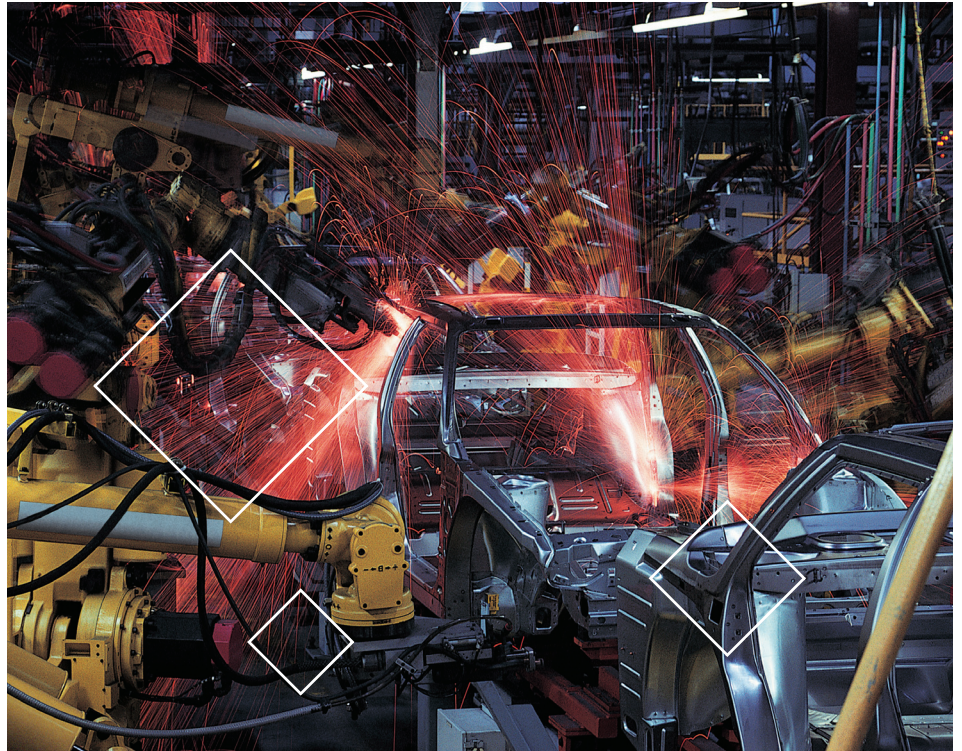
- Trench isolation
- High current metal
- High voltage
- Fuses - trimming, calibration, security, identification
- Engineered matching
- Noise immunity
- Tailored for harsh environments
- Inductive load switching and immunity to interference
- Engineered energy capability and robustness
- Good selection of devices with a wide range of features
- 105 V capability

SMARTMOS technology is the best process for the embedded world.

While today's high density CMOS processes have vast amounts of processing power, they cannot directly interact with most real world systems.

In embedded systems, these real world signals still need to get to the processor and loads need to be driven.

In addition, processors need to be provided with clean power and protected from the harsh electrical environment found in the real world.



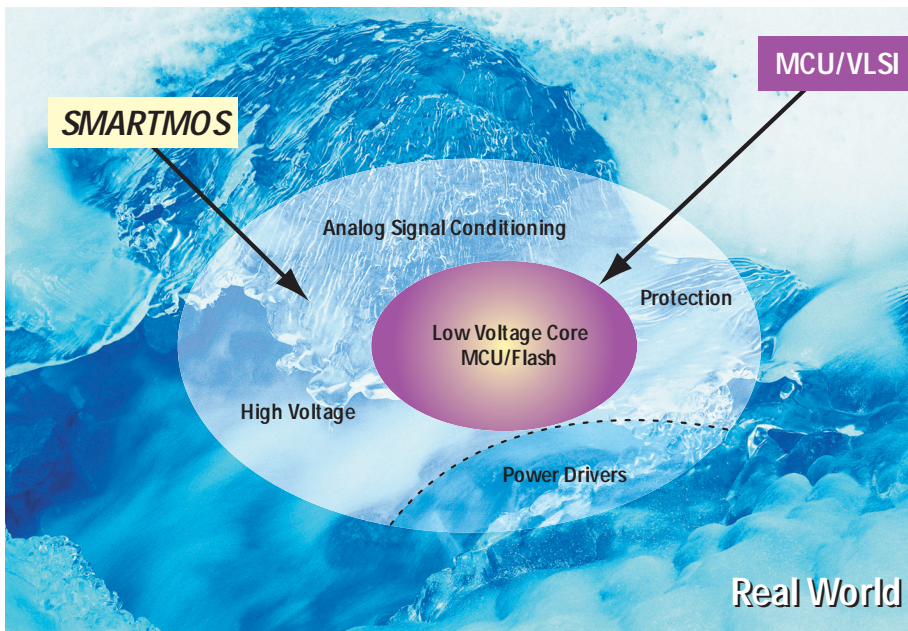
ROBUSTNESS

SMARTMOS technology is the robust technology for real world systems.

ICs using **SMARTMOS** technologies are ideally suited to all these tasks. The **SMARTMOS** process is a combinational BiCMOS-type of process that integrates precision analog, power devices and dense CMOS logic. System designers can eliminate dozens of components and combine all those functions into a single cost-effective IC including functions of voltage regulation, power MOSFETs, input signal conditioning, transient protection, system diagnostics and control.

SMARTMOS eight technologies support both medium voltage loads (MV) and low voltage loads (LV). The MV technology can drive loads up to 80 V, with high current metals (3 levels + power metal), capable of over 5.0 A loads. The LV technology can drive loads up to 30 V. Both variants have very dense CMOS logic capabilities (~250 k gates) utilizing 0.28 micron technology, integrated with precision analog and power driver devices.

With our standard products and custom design capability, what can we develop for your business opportunity?



SMARTMOS devices surround your delicate components (MCU/VLSI) with real world-capable analog and power interfaces.

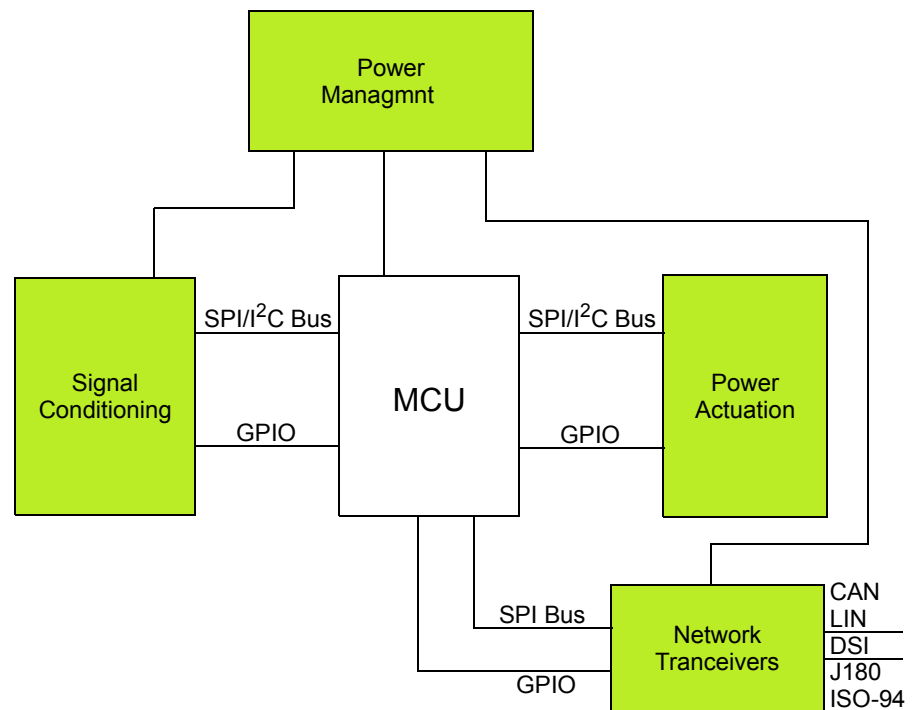
POWER

SMARTMOS devices manage the power and analog issues of the Real World

SMARTMOS technology represents precision analog, high-speed CMOS, and high voltage power devices combined into a single IC process. This robust process allows for optimal integration of a wide variety of mixed signal analog features, yielding best-in-class solutions for our customers.

Power management is an increasingly in-demand element of a mixed signal system. Freescale's **SMARTMOS** technologies provide excellent integration capabilities for low and medium power levels. For high power systems, advances in multi-die manufacturing technology allows the cost effectiveness of power HDTMOS and LFET devices to be combined with the advanced integration and control capability of the **SMARTMOS** process. These processes allow the customer to receive cost-effective, single-package solutions that decrease their system cost and time-to-market.

Freescale Analog ICs are designed to communicate with their host MCUs as well as enable network communication. Typical network protocols supported are: CAN, LIN, DSI, J1850 and ISO-9141.

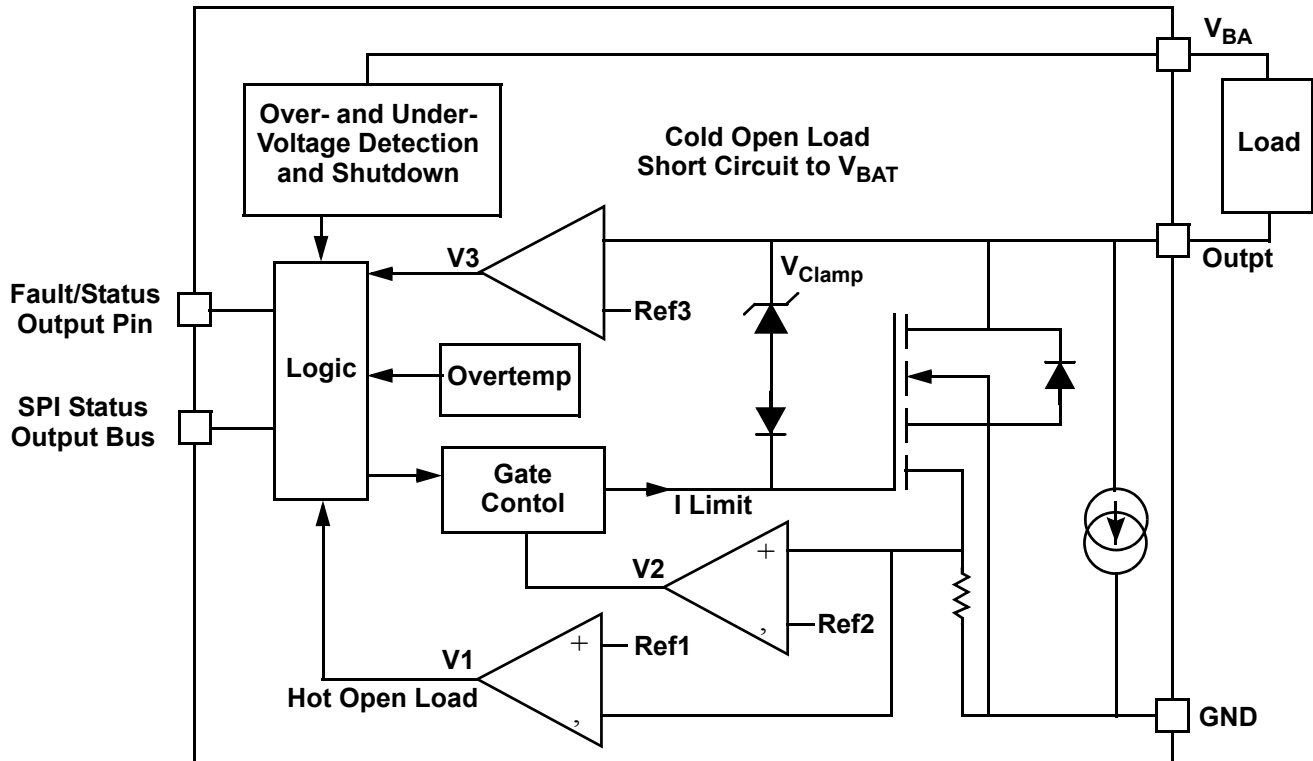


COMMUNICATING

SMARTMOS provides device solutions to connect MCUs to their system environment.

We combine these building blocks into many different ICs which fall into five broad categories:

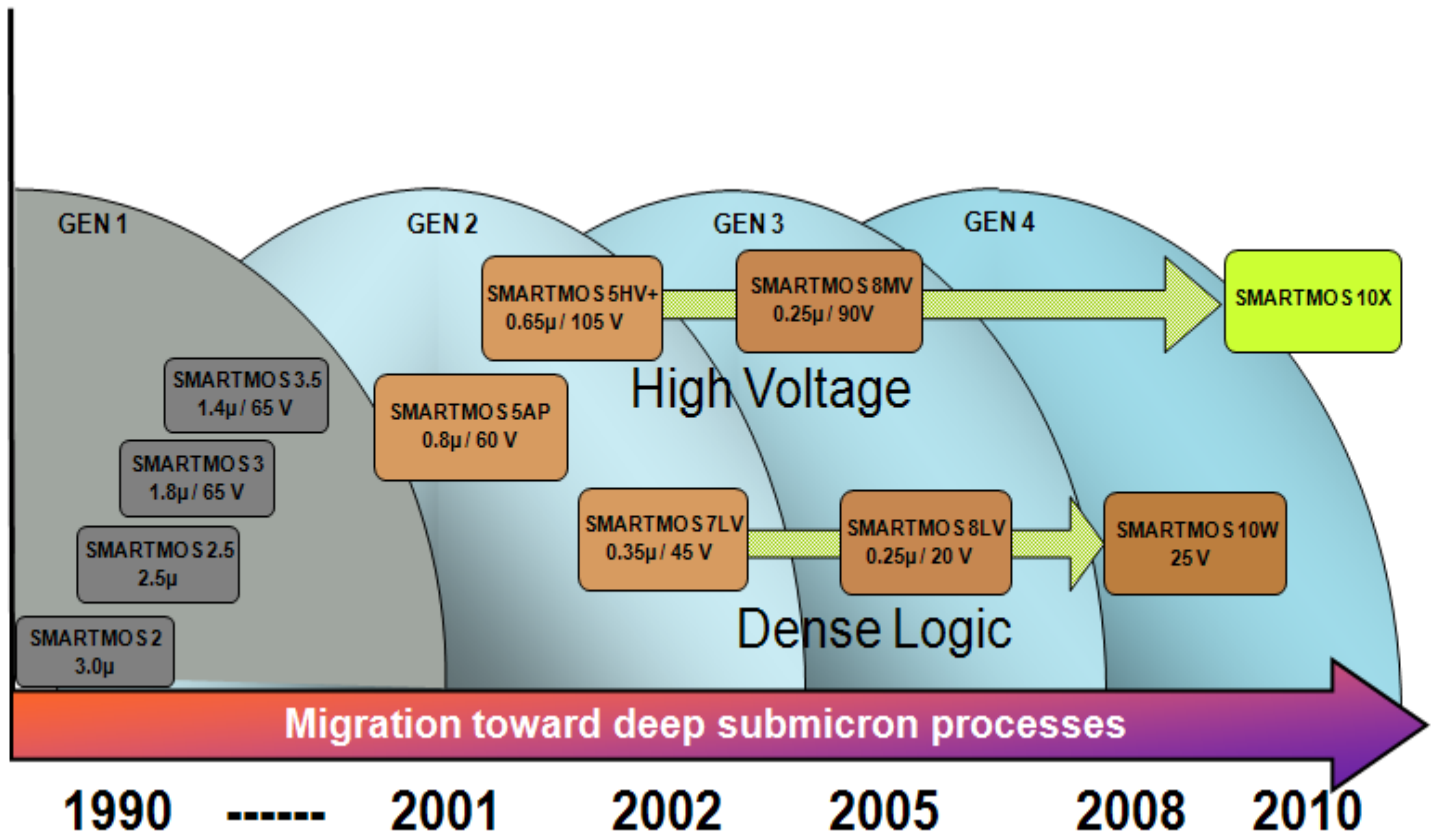
- Power Actuation
- Network Transceivers
- Power Management
- Signal Conditioning
- Embedded MCU + Power
- SPI, I²C or GPIO interfaces allow MCUs to control and communicate with **SMARTMOS** ICs
- Built-in diagnostics protect the device and communicate status to the MCU
- Physical interfaces (transceivers) enable the system to communicate reliably over a network
- Fuse technology allows setting of trim parameters and calibration of critical circuits via the network



PROTECTING

SMARTMOS Protection Features:

- Over-current detection or shutdown, with auto-retry
- Open load detection, with outputs ON or OFF
- Output current limiting
- Detection of shorts to ground or supply, with auto-retry
- Over-temperature detection or shutdown, with auto-retry
- Detection of over or under supply voltage for device/application protection
- Output Inductive load voltage clamping/protection
- Current and voltage waveshaping for radiated RFI reduction
- 2000 V / 200 V (human body model/machine Model) ESD (all pins)
- Up to 1000 V Charged Device model (CDM) ESD
- Full diagnostics and status reporting



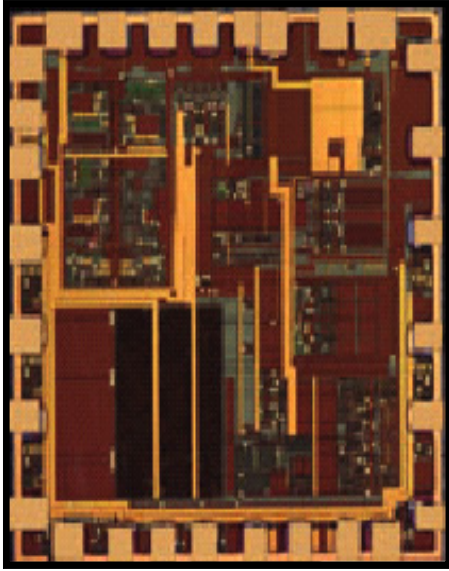
EVOLVING

Freescale will continue to evolve **SMARTMOS** to meet the world's needs.

Today's workhorse process for new designs is **SMARTMOS 8MV**, built on a 0.25 micron triple metal (plus a power metal layer) BiCMOS-type of process flow that can handle up to 90 V I/O. Complex ICs featuring tens of thousands of CMOS logic gates, voltage regulators, and multiple power FETs, with on chip diagnostics, are typically built with this process.

For devices operating at lower voltages, Freescale has **SMARTMOS 8LV**, a 0.25 micron **SMARTMOS** flow, with 20 V I/O that makes mixed signal power ICs with 250 k gates of CMOS logic practical. The **SMARTMOS eight** processes have a large selection of devices available to the designer, including MOS and bipolar transistors and diodes, several flavors of MOS power devices, programmable fuses for trim and personalization, and passive components, such as resistors and capacitors.

The next generation of both of these processes will be introduced soon, which will allow even greater levels of integration, higher load voltages, improved isolation and density, and enhanced analog features.

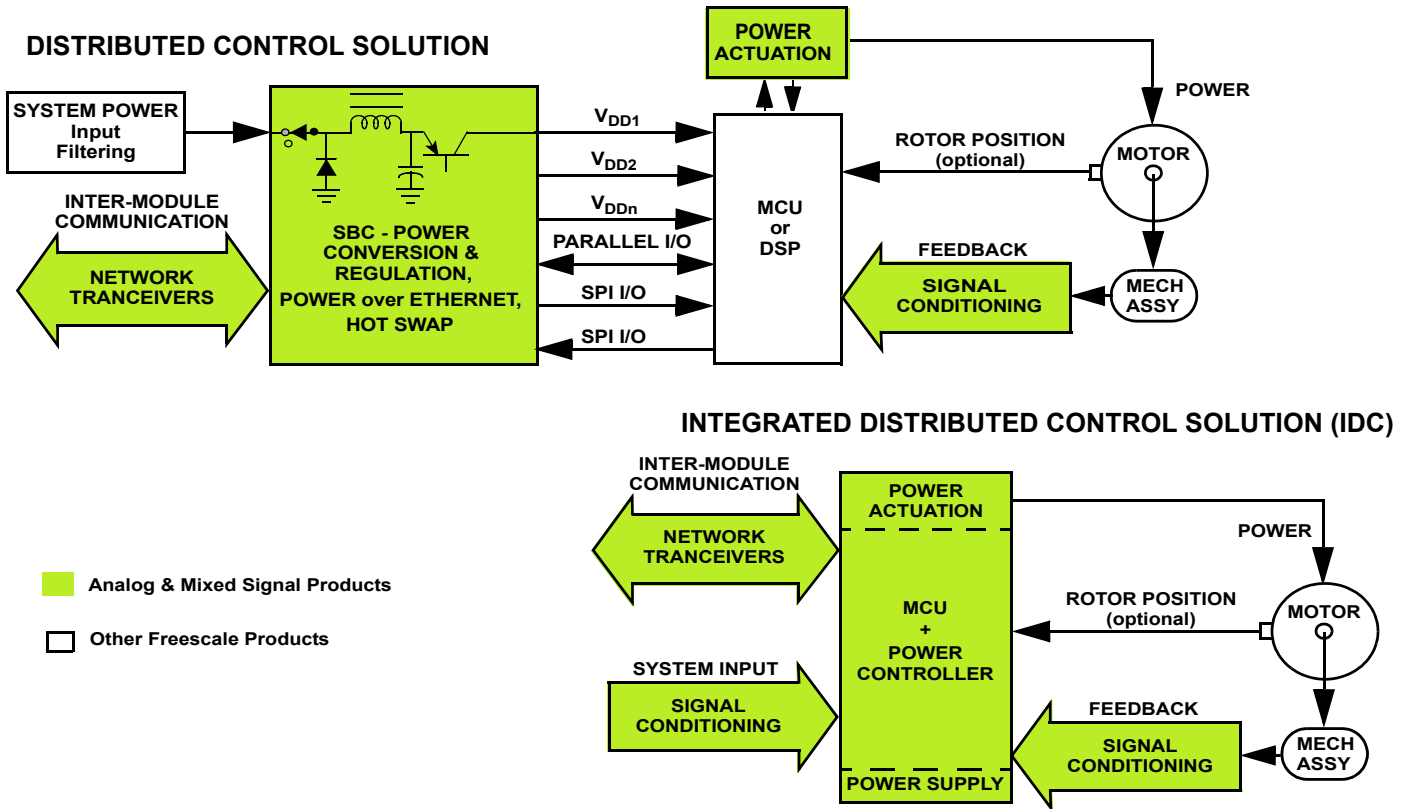
Analog to Digital Converter 8, 10 & 16 bit	High Speed CMOS 8LV: 100K's of gates, < 200MHz, 2.6V, 20 V I/O 8MV: 100K's of gates, < 200MHz, 2.6V, 90 V I/O	8/16-bit CPU HCS08/HCS12, 50MHz
Oscillator Crystal, internal - to 20 MHz, 2%		Fuses Trimming, ID, Calibrate, Security
8 to 16 Bit D-A Guaranteed monotonic		Analog MOS 20V or 90 V
Op Amps Rail-to-Rail		Power MOSFETs 8LV: 20V, 5A, 50mOhm 8MV: 90V, 5A, 50mOhm
Charge Pump Internal or external		Inductive Energy Clamps 1J, 50 μ s to 4ms
Comparators 5mV, or autozeroed		Independent Thermal Management Shutdown at 165 \pm 15 $^{\circ}$ C
Switched Cap Filters, Gain stages		Load Sensing Shorted Load Open Load
Precision References Bandgap - 1.2V, \pm 1% etc.		RF 900MHz Tx
Voltage Regulators DC/DC & Linear 5V, 3.3V, 2.6V etc.		SMARTMOS World

CONTROLLING

SMARTMOS technology serves the Analog, Logic and Power control world.

Our **SMARTMOS** integrated circuit products feature a rich set of mixed-signal building blocks including A/D and D/A converters, rail-to-rail op amps, comparators, charge pumps and gate drives, voltage regulators, precision references and dense digital logic. For driving loads we have power MOSFET devices with inductive energy clamps, independent thermal management, short circuit protection, and diagnostic load sensing.

SMARTMOS technology provides an appropriate balance of analog, power and CMOS logic, etc. to offer cost effective device solutions.



POWER MANAGEMENT

SMARTMOS products are the ideal technology complement for MCU and DSP based systems.

Every MCU requires analog support, power supply supervisory functions (Power Management), input signal conditioning (de-bounce and serial I/O support analog-to-digital conversion) and output power drivers (Power Actuation).

SMARTMOS ICs excel at communicating with MCUs and networks. Use of SPI to/from the MCU and network transceivers such as LIN, CAN, DSI, J1850, ISO-9141, PS15 etc. to the distributed system, supports control and diagnostics.

SMARTMOS technology is the best IC technology to control electrical loads and to measure inputs.

SMARTMOS ICs protect delicate VLSI MCU and memory ICs.

SMARTMOS provides power conversion in support of the needs of MCUs.

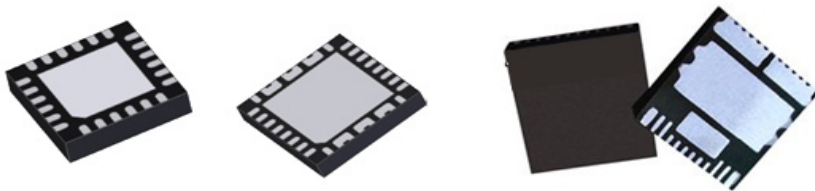
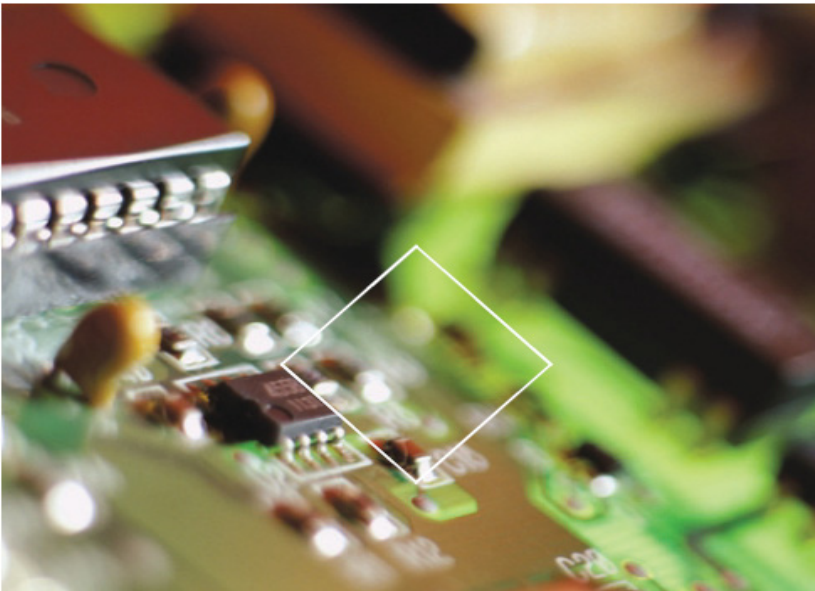
Analog Mixed Signal and Power Management Packaging Technology

Robust packaging is also a key technology:

Freescale puts solutions together in single packages to accommodate power, high voltages, communications, control and protection features.

Environmentally Preferred Packaging (EPP) is also a key mandate for Freescale Analog products

Refer to Packaging Brochure BR1568 at www.freescale.com.

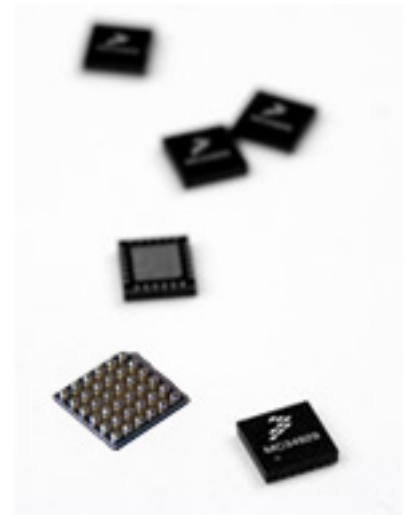


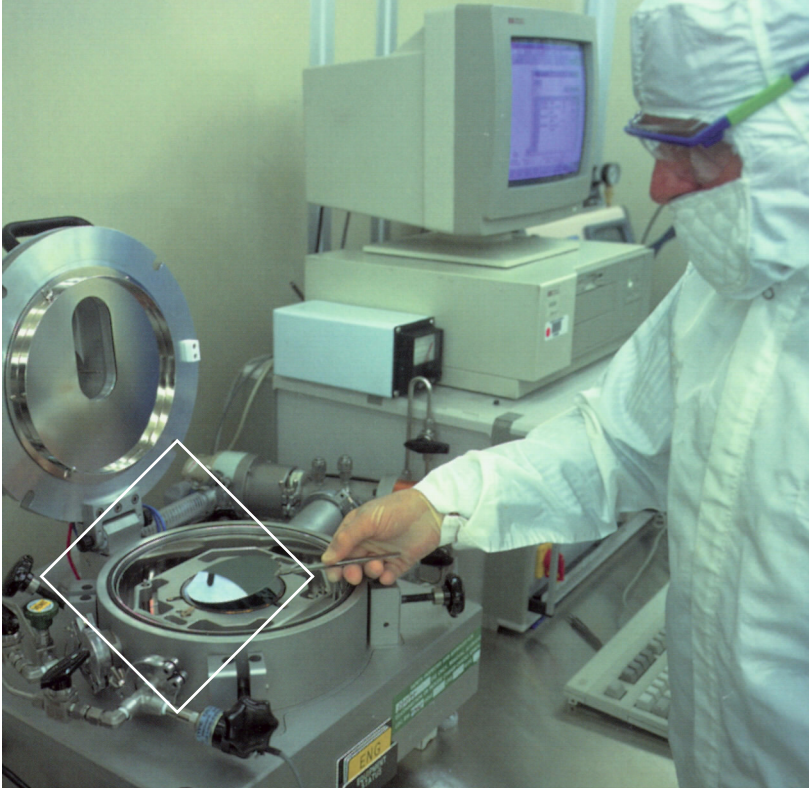
Robust packaging technology choices:

- Small Outline Surface Mount Packages
- Thermally Enhanced Small Outline Surface Mount Packages
- Heatsink Small Outline Surface Mount Packages
- Quad Flat Pack Surface Mount Packages
- Thermally Enhanced Quad Flat Pack Surface Mount Packages
- Quad Flat No-Lead Surface Mount Packages
- Power Quad Flat No-Lead Surface Mount Packages
- Leaded Chip Carrier Surface Mount Packages
- Wafer Level Chip Scale Packaging (WLCSP)

Packaging innovations include thermal enhancements as well as single package multiple die solutions:

- Single package, single chip, single function solutions
- Single package, Multi-chip, single function solutions for lower cost
- Single package, Multi-chip, multi-function solutions for integration, reduced time to market and lower cost





The Analog and Mixed Signal Products Division of Freescale has a long history serving the commercial and automotive marketplace, and a vast experience with the automotive industry's quality requirements / expectations.

We achieved QS9000 certification status in July 1998, TS16949 certification in 2004 and we use AEC-Q100 as the basis for our product stress test qualifications (products introduced prior to July 1998, may have limited qualification or other data available). Data may be available on a fee-for-service basis.

Learn More: For current information about Freescale products and documentation, please visit www.freescale.com.

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